Cold In-Place & Cold Central Plant Recycling Performance

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ARRA Disciplines

- Cold Planing (CP)
- Hot In-place Recycling (HIR)
- Cold Recycling (CR)
  - Cold In-place Recycling (CIR)
  - Cold Central Plant Recycling (CCPR)
- Full Depth Reclamation (FDR)
  - Soil & Base Stabilization
Improves existing materials in-place to provide greater structural support and reduction of imported material.
Recycle AC to:
- Stable Base
- Within 1” of less Supportive Material
CIR Current Offerings

Single Unit Train
- Mixing and sizing done in cutter housing
- Additive calculated on volume

Multi-Unit Train
- Closed loop sizing with screen and crusher
- Additive by weight
Cold Central Plant Recycling (CCPR)

Clean Rap = New Pavement:

- Stockpiled and kept clean
- Crushed RAP to gradation
- Mixed with bituminous recycling agent in central plant
- Transported to lay down area
- Paved as a recycled mix
- Compacted to specified density
- Readied for surface treatment
You can fractionate RAP and add new aggregate if required.
In-Place Recycling

► Reuses 90-100% of existing materials, in-place
► Costs 20-50% less than traditional methods
► Produces up to 90% less greenhouse gases
► Reduces user delays
  ▪ 20 to 40% faster construction
► Proven Performance
I-81 Virginia

- MP 213.7-217.0, southbound direction
- 2019 AADT = 24,000 vehicles per day with 30% trucks
- Paving between April and June 2011
- Calculated loading as of May 2022
  - 23.8 million ESALs (right lane)
  - 4.2 million ESALs (left lane)
I-81

- Rut depth 0.1 inch both lanes
- Left Lane IRI < 60 in/mile
- Right Lane IRI < 50 in/mile

4.2M ESALs

<table>
<thead>
<tr>
<th>Layer</th>
<th>Left Lane</th>
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<tbody>
<tr>
<td>4-inch New AC</td>
<td></td>
</tr>
<tr>
<td>5-inch CIR</td>
<td></td>
</tr>
<tr>
<td>Existing AC</td>
<td></td>
</tr>
<tr>
<td>Existing Aggregate</td>
<td></td>
</tr>
<tr>
<td>Subgrade</td>
<td></td>
</tr>
</tbody>
</table>

23.8M ESALs

<table>
<thead>
<tr>
<th>Layer</th>
<th>Right Lane</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-inch AC</td>
<td></td>
</tr>
<tr>
<td>8-inch CCPR</td>
<td></td>
</tr>
<tr>
<td>6-inch AC</td>
<td></td>
</tr>
<tr>
<td>12-inch FDR</td>
<td></td>
</tr>
<tr>
<td>Subgrade</td>
<td></td>
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</tbody>
</table>
VDOT Sections with CCPR at NCAT Test Track

S12
- 4-inch AC
- 5-inch CCPR
- 8-inch FDR
- Subgrade

N4
- 4-inch AC
- 5-inch CCPR
- 6-inch Agg
- Subgrade

N3
- 6-inch AC
- 5-inch CCPR
- 6-inch Agg
- Subgrade
NCAT Testing - Findings

- 6” AC section (N3) stopped after 20 million ESALs, no condition change
- 4” AC section (N4) currently at 35+ million ESALs
  - minor cracking (< 0.1% wheel path area)
- Calculated layer “a” coefficient 0.36 – 0.43 in N3 and N4
- CCPR+FDR section (S12) stopped after 30 million ESALs, no condition change
  - Rebuilt in 2022 to investigate re-recycling CCPR
  - Perpetual type performance
Lab Testing

- NCHRP Project 09-51, Material Properties for CIR and FDR for Pavement Design
  - PI: University of MD

![Images of cylindrical samples with measurements labeled 110 mm and 50 mm.]
Lab Testing - Findings

- FDR has similar stiffness as CIR and CCPR
- No significant difference between foam and emulsion for CIR and CCPR
- Use of active fillers (cement or lime) had a positive influence after 1 year
  - Wirtgen recommends 1% maximum cement foamed asphalt
  - ARRA recommends minimum 2.5:1 ratio residual asphalt to cement for emulsified asphalt
NCAT Lee Road 159 Preservation Study
CCPR Base in Section L20

- 3/4 inch HMA Thin Lay over 5 inch CCPR
- 2% foamed asphalt, 1% cement
- Placed 2012, 10 years Over 1.6 M ESALs
- Performance
  - < 7% low severity cracking
  - < 3 mm Rutting
  - IRI increased from 120 – 142 in/mile
MNRoad 70th Street

- Pre-reconstruction Avg. IRI 385 in/mile
- Existing road 4 inches over 6 inches Granular Base with clay subgrade
## MNRoad 70th Street

- 1 inch HMA Thin Lay
- 3 inches CCPR or CIR
- 1 inch old pavement and 6 inches Granular Base
- Clay subgrade
- 500 ft sections

<table>
<thead>
<tr>
<th>Section/Mix</th>
<th>Binder</th>
<th>Cracking</th>
<th>Rutting</th>
<th>IRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>7003 CIR</td>
<td>2.6% Foam 1% Cement</td>
<td>184 ft</td>
<td>3 mm</td>
<td>75</td>
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<tr>
<td>7004 CIR</td>
<td>2.8% Emulsion</td>
<td>126 ft</td>
<td>5 mm</td>
<td>70</td>
</tr>
<tr>
<td>7005 CCPR</td>
<td>3.5% Emulsion</td>
<td>126 ft</td>
<td>5 mm</td>
<td>80</td>
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<tr>
<td>7007 CCPR</td>
<td>2.3% Foam 1% Cement</td>
<td>115 ft</td>
<td>2 mm</td>
<td>70</td>
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</table>
SR 101 Indiana

► Project Background
- 8-Mile Length
- Avg. IRI 153 in/mile
- 31% Roadway Poor Condition
- Lack of Shoulders

► Proposed Solution
- Widen Pavement from 20 to 26 Feet
- Increase Subgrade Strength
- Reconstruct Pavement
Pavement Condition
- Widespread age-related distress and fatigue
- Beyond point patching & mill & fill cost effective
- 10+ Inches HMA
- Delaminated/Unbound pavement layers
- Asphalt stripping due to moisture infiltration
SR 101 Solution: FDR + CCPR

- Milled off 8 inches of existing pavement
- Hauled and stockpiled at central location
- Crushed to 1.25 inch minus
- Produced CCPR mix
SR 101 Solution: FDR + CCPR

- Trenched 3’ on each side
- Performed FDR and Spread and Compacted 26’ wide, 10” deep
- Utility Work Performed Prior to FDR
SR 101: Emulsion CCPR Construction

- Placed 6” CCPR Mix
- 2.5% Engineered Emulsion
- Roadway was Profile Milled to correct cross slope
- Placed 2” 12.5 mm HMA surface mix
- Final section 89% Recycled Material
SR 101 – 8.62 miles or 17.24 lane miles

FDR/CCPR Cost
- $4,970,715 (awarded)
- $288,325/lane mile

Pavement Replacement
- $11,939,980 (DOT estimate)
- $692,574/lane mile

Percent Difference: 58%

Source: Flora, Purdue Road School, 2020
More Information

Basic Asphalt Recycling Manual

www.roadresource.org
ARRA Best Practice Guidelines

► Series 100 Construction Best Practice Guidelines
► 200 Series Project Sampling & Mix Design Guidelines
► 300 Series QC Guidelines
  ▪ Recommended Quality Control Checks and Remediation Actions
► Available for CIR, CCPR, FDR at: www.arra.org/page/Resources

Recommended Construction Guidelines
For
Cold Central Plant Recycling (CCPR)
Using Bituminous Recycling Agents
CR102
Revised 11/02/2017

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Responsible Renewal. Reliable Results.

NOTICE
It is not intended or recommended that these guidelines be used verbatim within a specification. Owner agencies should use them to help establish their particular project specifications. Owner agencies should understand that all geographical areas and pavement rehabilitation/reconstruction projects are unique and the availability of materials and equipment may vary as well. ARRA assumes no liability for utilization of these guidelines by any individual or entity. Contact ARRA for answers to questions and for a list of ARRA member Contractors and Suppliers.

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Deliverables

- Guide Specification in AASHTO format
- Commentary
- Best Practice Guideline
- QA Guide
- Referenced ARRA’s Best Practice Guidelines (CR101 & CR 301)

In publication
Summary

► CIR & CCPR are economical and sustainable construction and maintenance procedures
► CIR is best suited for cracked pavements with sound bases
► CCPR can be considered anywhere one would place multi-lift HMA
► CIR & CCPR require a wearing surface
Thank You

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